Transport Committee Inquiry into Vehicle Type Approval

Evidence of the Institute of Air Quality Management

The Institute of Air Quality Management

1. The Institute of Air Quality Management (IAQM) represents more than 300 air quality professionals working in the UK and, as such, has a direct interest in the way government at all levels seeks to manage and improve air quality. We aim to be an authoritative voice on matters of air quality, using the expertise of our members. This submission represents the view of the IAQM's committee, and relates solely to the exhaust emissions element of the vehicle type approval system.

Executive Summary

2. The gap between type approval (TA) and real world NO_x emissions has been known by the UK government since at least 2010 and well before then for CO_2.

3. For CO_2 the gap has grown over the last decade and the reported values bear little relationship to reality. This misleads the consumer and fails to achieve climate change mitigation targets.

4. The UK government lacks the expertise to effectively regulate a very technical industry. It may also lack the desire, as the industry has significant political influence as a major employer.

5. The regulatory framework of many type approval authorities and technical service organisations, with the manufacturers funding the latter directly, is weak. The technology for measuring real driving emissions now exists, and should form a central plank of type approval. There is need for independent in-service surveillance, preferably undertaken by the government.

6. An effective enforcement regime is required that withdraws TA from failing vehicles, with suitable compensation for the vehicle owner. Given the complexity of the issues, and the imbalance of knowledge, a strong enforcement system is needed.

Current Type Approval Arrangements

7. The current TA arrangements have evolved since 1970 when the first voluntary standard was introduced[1]. The first mandatory standard for cars (Euro 1) came into effect for new types of vehicle in July 1992 and all new vehicles at the end of December 1992. Euro 1 for heavy duty vehicles was introduced from July 1992 / October 1993, and for vans from October 1993 / October 1994. Over the last 20+ years there have been many changes to the TA test procedures. These have included new test cycles, (e.g. the New European Driving Cycle,

[1] By UNECE

NEDC, for LDVs[2]/transient test cycle for HDVS[3]), cold start, durability, on-board diagnosis, defeat devices, in-service checks etc. Test procedures has been established for each of these elements.[4] Euro 6c / VI[5] diesel vehicles / engines are also to be subject to the Particle Measurement Programme (PMP) test and associated particle number (PN) limits[6]. Other changes in the pipeline include the Worldwide Harmonised Light-duty Test Procedure (WLTP) and real driving emissions (RDE) testing.

8. Regulation EC 715/2007 prohibits the use of defeat devices that reduce the effectiveness of emission control systems. The prohibition does not apply, however, where: (a) the need for the device is justified in terms of protecting the engine against damage or accident and for safe operation of the vehicle; (b) the device does not function beyond the requirements of engine starting; or (c) the conditions are substantially included in the test procedures for verifying evaporative emissions and average tailpipe emissions.

9. The aim of the TA test is to be reproducible, such that a vehicle / engine tested or witnessed by any approved technical service gives the same results. The TA tests standardises a range of factors that influence emissions such as road gradient, traffic conditions, ambient temperature and driver behaviour. These do not necessary relate specifically to the UK; for example, the test temperature is higher than typical UK temperatures[7].

10. For the air quality pollutants (AQPs)[8], manufacturers tend to use one worst case vehicle for TA. If this passes, then the assumption is that all versions / variants of the model will also pass. For CO_2 there is no pass or fail test. Instead the emission data is used for a variety of purposes including consumer information, VED and the individual manufacturer's CO_2 target. The manufacturers tend to test CO_2 emissions from each version / variant separately, because this is beneficial for meeting the company's targets where every gram / km counts. The CO_2/AQP tests are typically performed on different vehicles, possibly overseen by different laboratories[9] despite the test procedure being the same.

11. There are several 'flexibilities' (i.e. test tolerances) and insufficiently well-defined test parameters that affect the results. There is evidence that car manufacturers have used these flexibilities to their advantage to ensure low reported CO_2 emissions (see ICCT, 2015: http://www.theicct.org/sites/default/files/publications/ICCT_LaboratoryToRoad_2015_Report_English.pdf). Some of these will be addressed with the introduction of the WLTP, but it is

[2] Light duty vehicles
[3] Heavy duty vehicles
[4] The exhaust emissions test procedures are known as Type 1 tests
[5] Light duty vehicle emissions standards are denoted with Arabic numerals (1, 2, 3 etc.) and heavy duty engine emissions standards by Roman numerals (I, II, III etc.). Euro 1/I standards were first implemented in 1992, with the most recent Euro 6 and VI implemented from 2014 and 2013 respectively.
[6] The mass of particulate matter (PM) from diesel vehicles/engines has been limited for many years; however a particle number (PN) limits was introduced, essentially to require the fitting of a diesel particle filter (DPF).The work developing the test procedure and limit was led by the UK Department of Transport.
[7] 20-30^{O}C for NEDC; likely 14^{O}C for European version of WLTP. Average UK temperatures are closer to 10^{O}C
[8] Nitrogen oxides (NOx), carbon monoxide (CO), hydrocarbons, particulate matter (PM), particle number (PN)
[9] The TA authority typically appoints 'technical services' who either undertake or witness the tests. In the UK VCA performs both roles

unlikely that any test procedure can be completely fool proof or reflect real world driving completely. We are not aware of any studies showing how representative the new test procedure will be of UK driving conditions, as it is based on driving conditions in the USA, Asia and Europe. As the motor industry is global, it is to their advantage to have harmonised tests to reduce the cost of developing engines for different markets[10]. It is important that when there are any changes to the TA procedure that the limit values are adjusted to ensure that there is no loosening of the standards.

12. The development of test procedures and associated limit values is technically complex. The industry dominates these discussions because they have the greatest technical knowledge. We are concerned that the UK Government is lacking the expertise and resources to scrutinise proposals developed by industry, let alone lead these debates in the way it did in the past. For example, the UK was the global leader of the development of the PMP procedure and PN limits in the 2000s.

The gap between emissions detected in the TA test and real driving conditions

13. The discrepancy between the increasingly more stringent NOx[11] emission limits[12] and real world emissions has been known for at least five years. A Defra research contract to understand why ambient nitrogen dioxide (NO_2) concentrations were not improving as anticipated identified the issue using remote sensing data in 2010. A presentation given by a Defra official at that time stated:
    - *NOx emissions from petrol cars have decreased ca. 96% since the early 1990s.*
    - *Diesel car emissions have increased or at best been stable for the past 25 years or so.*

14. The European Commission's Joint Research Centre in Ispra, Italy undertook portable emissions measurement system (PEMS) [13] research at around the same time, showing that when driven under normal driving conditions NO_x emissions from Euro 5 cars were several times the emission limit. The International Council for Clean Transportation (ICCT) has shown that the average on-road driving NOx emissions for Euro 6-equivalent diesel vehicles[14] was seven times the Euro 6 limit (ICCT, 2014; http://www.theicct.org/real-world-exhaust-emissions-modern-diesel-cars). They noted that there were remarkable differences in the performance of the vehicles tested, supporting the view that the technology for clean diesels exists.

15. The main technology deployed to reduce NO_x emission from diesel vehicles is selective catalytic reduction (SCR), although some vehicles use lean NO_x traps (LNTs). SCR requires the use of urea (AdBlue). High NO_x emissions occur during rapid acceleration when it may be difficult to inject the optimum amount of urea. The issue with LNT systems is different. These systems have a fixed NO_x capacity and under high-load situations NO_x can break

[10] Although it appears that different jurisdictions may introduce variations.
[11] NOx = nitrogen oxides = nitric oxide (NO) + nitrogen dioxide (NO_2).
[12] Reduced from 500 mg/km in 2000 (Euro 3) to 80 mg/km in 2014 (Euro 6).
[13] That is instrumented vehicle that measure the instantaneous emissions while driving.
[14] The mandatory requirement did not come into effect until September 2014; and one tested vehicle was a US model.

through. ICCT concluded that the vehicle NO_x control strategies are optimised for the current type-approval test procedures, but are not sufficiently robust to give acceptable on-road performance. Similar conclusions have been drawn by other researchers (e.g. Ligterink *et al*. , 2013. https://www.tno.nl/media/1969/investigations_emission_factors_euro_6_ld_vehicles_tno_2013.pdf).

16. More recent data suggests that average NO_x emissions from Euro 6 diesel cars are 3.7 times the limit value while Euro 6 petrol cars are under the limit value (Emissions Analytics , 2015, no hyperlink available). In addition the proportion of the NO_x emitted as nitrogen dioxide (NO_2) has grown and for recent diesel cars is approaching 50%. Direct vehicle emissions of NO_2 are important because this leads to high NO_2 concentrations close to roads where people may be exposed. The EU ambient air quality limit values for NO_2 are exceeded in 21 EU Member States; and the evidence of the health effects is growing. In 2013 the World Health Organization (WHO) stated that health effects may occur at levels below the current NO_2 ambient limit value and in 2015 Defra estimated that there are approximately 29,000 premature deaths each year due to exposure to this pollutant in the UK. In the Netherlands the higher than expected NOx emissions from heavy duty vehicles have more than doubled the total road length with possible exceedance of the ambient NO_2 limit value; from approximately 100 km to 250 km along cities streets and motorways (Velders *et al*. , 2011. http://www.sciencedirect.com/science/article/pii/S1352231011002603).

17. Euro 6 petrol cars have significantly lower NO_x and NO_2 emissions than diesel cars. The NO_x limit value is 25% lower, emissions are well controlled in real driving conditions, and the proportion emitted as NO_2 is substantially lower. If there had not been a shift from petrol to diesel cars, particularly over the past decade or so, ambient NO_2 concentrations would have been lower.

18. ICCT have also found that there is also a significant gap between TA and real world CO_2 emissions. This difference has increased from approximately 10% in 2001 to around 40%. The gap is particularly high for hybrid vehicles and for vehicles using stop-start technologies (ICCT, 2015: http://www.theicct.org/sites/default/files/publications/ICCT_LaboratoryToRoad_2015_Report_English.pdf).

19. We are not suggesting that the motor manufacturers have acted illegally, but that they have used the test flexibilities / tolerances to their best advantage to help meet their CO_2 targets. It should be noted that during TA a manufacturer may test a single 'worst-case' pre-production car for NO_x (and the other air pollutants) but test a range of versions / variants for CO_2 emissions, despite a common test procedure. This is because the former is a pass or fail test whereas the former is used to assess compliance with the manufacturers' sales weighted CO_2 target, and therefore it is not to their advantage to test only one 'worst case' version. There is a need for transparency of the vehicle and test parameters to enable external review.

Real World Testing

20. As the technology (PEMS) now exists for gaseous emissions to be tested under real world driving conditions (i.e. RDE) these tests should be fully integrated into TA. There has been much debate about the conformity factor but the technical requirements, such as the data which can be excluded and length of test cycle, need to be carefully scrutinised. These data will be collected by the manufacturers for a limited number of vehicles, and are unlikely to be publicly available. For example will they only submit favourable data, retesting until they get a good conformity factor? Would it be better to have a not to exceeded NOx limit covering all driving conditions?

21. Very little independent testing by EU governments of vehicle emissions takes place; probably only a handful of vehicles each year. Where this identifies an issue, information is typically provided to the manufacturer but there is no enforcement. The UK government should undertake surveillance testing using RDE, and be given powers to enforce the emission requirements.

22. We believe emission limits should be technology neutral in the future, and no allowance should be made for diesel light duty vehicles as is the case in the USA. A new emission standard of 60 mg / km should be introduced as early as possible for diesel cars (i.e. the current petrol limit), with a RDE conformity factor of 1 for diesel and petrol light duty vehicles.

23. For heavy duty engines the 'not to exceed' emission limit to control off-cycle emissions requires the manufacturer to choose the vehicle to be tested based on its highest sales. More heavy duty engines are used in long distance lorries than in urban buses which have a specific operating cycle, often in very congested traffic. It is important that the RDE from these vehicles are also measured and controlled, as their performance is likely to be different from long-distance lorries. Therefore, the current requirement should include a wider range of end-uses of the engine.

24. The final details of the light duty[15] RDE testing regime are important and have yet to be finally agreed and published[16]. The proposed RDE procedures include PEMS testing over a 90 to 120 minute long trip, which would include urban, rural and motorway driving on working days. The test would include cold start but data would be excluded from the evaluation until the engine coolant temperature reaches 70 ^{o}C or for a maximum of five minutes. The PEMS data will be analysed statistically over periods of similar duration as the Type 1 test. However, these details remain subject to final agreement.

[15] Vans should be included in the RDE requirements as soon as possible.

[16] The press release from the European Commission implies everything has been agreed; only in the final sentence does it mention that it requires the European Parliament and Council to agree. http://europa.eu/rapid/press-release_IP-15-5945_en.htm

Legislative Framework

25. Each Member State has a TA authority (VCA in the UK). These authorities appoint technical services to undertake or witness the TA tests. In the UK VCA is also a technical service. Any manufacturer can use any technical service; generally commercial organisations who compete for business in many countries. Therefore, these organisations have a financial interest in getting repeat business and helping manufacturers to get the best out of the test flexibilities / tolerances. It would be better if there was more distance between the manufacturer and technical service organisation, e.g. if the manufacturers paid the TA authority, which in turn appointed and paid the technical services company.

26. Only one TA authority has to approve a model for it to be allowed to be sold across the EU and therefore the system is only as good as the weakest TA body / technical service. Not all elements of the TA are tested by the same organisation or even in the same country, and the manufacturers can 'cherry pick' the technical services organisation.

27. Pre-production vehicles are tested, with random testing of conformity in production. The TA authorities should check there is an internal quality control system. Unlike the US these bodies cannot demand that a random car is taken from the assembly line and tested without prior notice.

28. We believe that additional checking is required using PEMs to check in-service vehicles under real driving conditions. Ideally this would be independent of the manufacturers' testing and undertaken by or on behalf of government, ideally with Member State co-operation to reduce the burden. If this testing focused on the most popular models and the results was made freely available to the public it would help restore consumer confidence regarding vehicle NO_x and CO_2 emissions, and be useful to inform vehicle choice.

29. There may also need to be an EU-wide enforcement body that can order additional tests and, when appropriate, take timely decisions to withdraw TA. There would need to be a system of compensation for the vehicle owners, which would put pressure on the industry to produce clean and safe vehicles.

30. Finally we also believe that there should be a specific limit value for NO_2, rather than just NO_x. This pollutant is currently measured in the TA test (the instrument used measures both NO and NO_2 and adds them to derive the NOx emissions).

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Reference not hyperlinked

Emissions Analytics, 2015. Presentation by Nick Molden, CEO, to Air Quality News Conference, 1 October 2015. Birmingham.